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(54) **MULTI-VANE CENTRIFUGAL BLOWER**

ZENTRIFUGALGEBLÄSE MIT MEHREREN BLÄTTERN

SOUFFLANTE CENTRIFUGE MULTI-PALES

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• **IWATA, Tooru,**
c/o Kanaoka Factory, Sakai Plant
Sakai-shi
Osaka 591-8511 (JP)

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(74) Representative: **Hoffmann Eitle**
Patent- und Rechtsanwälte PartmbB
Arabellastraße 30
81925 München (DE)

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(73) Proprietor: **DAIKIN INDUSTRIES, LTD.**
Osaka-shi, Osaka 530-8323 (JP)

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(72) Inventors:
• **YAMASAKI, Takahiro,**
c/o Kanaoka Factory, Sakai Plant
Sakai-shi
Osaka 591-8511 (JP)
• **KOMATSU, Akira,**
c/o Kanaoka Factory, Sakai Plant
Sakai-shi
Osaka 591-8511 (JP)

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Description

TECHNICAL FIELD

[0001] The present invention relates to a multi-blade centrifugal fan with a multi-blade centrifugal impeller placed within a fan casing.

BACKGROUND ART

[0002] As shown in Figs. 11 and 12, a conventional multi-blade centrifugal fan is formed of a fan casing 1 and a multi-blade centrifugal impeller 2. The fan casing 1 is provided with bellmouths 4 each forming an air intake. A number of blades 6 are annularly arranged in the impeller 2, which blows out air W drawn in through the intakes 7 which face the above described bellmouths 4 in the centrifugal direction through the above described blades 6. The outer peripheral end portions of the above described impeller 2 are provided with retainer rings 10 for retaining the above described blades 6 (see Patent Document 1). The impeller 2 is provided with a main plate 8 and a bearing 9.

Patent Document 1 : Japanese Laid-Open Patent Publication 2001-173596

[0003] Further, US 2002/0131861 A1 discloses a centrifugal blower having a noise-reduction structure. In a predetermined range from a nose portion toward a scroll finish side in a scroll casing of a centrifugal blower, a first clearance dimension on a side of a suction port between an outer periphery of a centrifugal fan and a side plate of the scroll casing is set smaller than a second clearance dimension on a side opposite to the suction port between the outer periphery of the centrifugal fan and the side plate of the scroll casing. In addition, in the vicinity of the nose portion, a first wall part of the scroll casing on the side of the suction port protrudes toward a scroll finish side, from a second wall part of the scroll casing on the side opposite to the suction port.

[0004] EP 1 178 215 A2 discloses a centrifugal multi-blade blower including a first counter-flow prevention means that prevents part of air flowing through a scroll chamber from flowing through a first aperture defined between a multiblade fan and a suction-side case plate of a scroll casing back to a suction port, and a second counter-flow prevention means that prevents part of air flowing through the scroll chamber from flowing through a second aperture defined between the multiblade fan and a motor-side case plate of the scroll casing back to the upstream side of the scroll chamber. A length L1 of the scroll chamber measured in the motor-shaft axial direction is dimensioned to be longer than a length L2 of the multiblade fan measured in the motor-shaft axial direction. Additionally the scroll chamber is gradually enlarged toward a discharge port of the casing.

[0005] US 4,432,694 A discloses a centrifugal blower including a casing formed with a discharge port and a suction port, and an impeller mounted in the casing and

having a plurality of backwardly curved vanes arranged circumferentially of the impeller. The suction port has a semicircular suction member located in spaced juxtaposed relation to a semicircular curled portion formed at the forward end of a shroud of the impeller. An annular guide plate may be attached to the inner side of the suction member and formed at its open end with a wall portion disposed along the shroud which is formed at its forward end with an annular wall extending into a space defined between the suction member and the guide plate. Hair may be provided on one of opposed wall surfaces of the suction member and the annular wall of the shroud. A similar blower is disclosed in DE 42 27 901 A1.

[0006] US 5,352,089 discloses a multi-blade fan having a fan assembly including a bottom plate and a plurality of circumferentially spaced blades and a casing for the fan assembly therein having an outlet duct extending therefrom for discharge of the air flows. The fan assembly includes an annular shroud connected to the axial ends of the blades remote from the bottom plate. The casing includes a bottom wall for rotatably connecting the fan assembly, a top wall for defining an air inlet for axially introducing the air into the casing, and a tubular wall connecting the bottom and top walls. The top wall of the casing adjacent to the inlet opening forms an annular projection having a bell cross sectional shape opened inwardly so that an axial end of the shroud extends thereto. The bell cross section portion radially extends to a portion that is inclined downwardly in the outward direction, which faces the shroud so that a small gap extending radially is created. The top wall or bottom wall of the casing at its radially outer portion can be downwardly inclined. The tubular wall of the casing can also be inclined so that the bottom end of the tubular wall is spaced radially outward from its center. US 6,224,335 B1 discloses an automotive air conditioning assembly having a fan that is molded by a technique that inevitably leaves the lower hub and upper rim radially staggered relative to one another. Therefore, a substantial length of the edges of the blades' bases are unsupported by the incomplete hub, and the air forced radially outwardly between the blades has no fan structure to confine it at that point. The invention provides a fan housing having a wall portion specially shaped so as to provide the air confinement function that the missing section of the fan hub cannot.

[0007] US 5,588,803 A discloses a centrifugal blower impeller having wide, backwardly inclined blades of the type that require the addition of a locking ring in order to stiffen and stabilize the blade tips. The blade tips and locking ring incorporate special notches and interfitting channels that allow the locking ring to be simply pushed down and onto the blade tips, self retaining without the necessity of any extra assembly steps like staking or welding. The side edges of the blade tip notches wedge against the walls of the channels if the blade tip attempts to bend in either direction.

[0008] US 6,168,734 B1 A method for dynamically balancing a centrifugal blower fan wheel is disclosed. The

method includes the steps of determining an amount and location of change in the fan inlet ring of the blower wheel which is required to balance the blower wheel. Once this determination is made, the radial thickness of the inlet ring is increased at a predetermined location to provide the proper amount of balance to the blower wheel. A mold is described for accomplishing this method.

DISCLOSURE OF THE INVENTION

[0009] In the case of the multi-blade centrifugal fan disclosed in the above described Patent Document 1, air W drawn in through the bellmouths 4 passes through the intakes 7 and the inside of the impeller 2 so as to be blown out in the centrifugal direction through the blades 6, and then flows out into the fan casing 1. However, circular flows W^r are created around the end portions of the impeller 2, that is to say, around the retainer rings 10 provided in the vicinity of the intakes 7. When these circular flows W^r are created, the efficiency in the blowing of wind of the multi- 5 blade centrifugal fan lowers, and noise is inevitably increased.

[0010] The present invention is provided in view of the above described points, and an objective thereof is to prevent circular flows in the end portions of the impeller by a simple structure.

[0011] A multi-blade centrifugal fan according to the present invention is defined by the combination of features of claim 1. Dependent claims relate to preferred embodiments.

[0012] In accordance with the present invention, a multi-blade centrifugal fan is provided with a fan casing and a multi-blade centrifugal impeller. The fan casing is provided with a bellmouth forming an air intake and an air outlet. The fan casing also has a tongue portion. The multi-blade centrifugal impeller is arranged inside the fan casing and has a number of annularly arranged blades. The impeller blows out air drawn in through the intake which faces the above described bellmouth in the centrifugal direction through the above described blades. In this multi- blade centrifugal fan, a retainer ring for retaining the above described blades is provided in at least one end portion in the axial direction of the above described impeller, and a cylindrical body is integrally provided in such a manner as to extend from the outer end of this retainer ring.

[0013] In the above described configuration, air drawn in through the bellmouth passes through the intake and the inside of the impeller so as to be blown out in the centrifugal direction through the blades, and then flows out into the fan casing. At this time, circular flows toward the intake side are prevented in the end portions of the impeller by the cylindrical body, which is integrated with and extends from the outer end of the retainer ring. Accordingly, the efficiency in the blowing of wind is increased, and noise is reduced. In addition, the outer ends of the retainer ring integrally extend, and therefore, the end por-

tions of the impeller 2 are in an open state. Accordingly, it is possible to form the impeller 2 as an integrated mold of a synthetic resin, which greatly reduces in the costs.

[0014] The longitudinal cross section of the above described cylindrical body extends in a circular arc from the longitudinal cross section of the above described retainer rings such that a circumferentially outer side of the cross section of the cylindrical body extends outwardly in the centrifugal direction towards an axially outer end of the cylindrical body. This structure is preferable in that blown out air flow is guided smoothly.

[0015] The above described cylindrical body reaches a location which is substantially the same as the end of the above described bellmouth on the outlet side.

[0016] A predetermined clearance may be set between the above described cylindrical body and the above described tongue portion. In this case, backflow through the clearance from the tongue portion in the fan casing is effectively prevented.

[0017] The above described impeller may be of a one-intake type with an intake only at one end in the axial direction of the impeller. In this case, the configuration of the impeller when formed as an integral mold of a synthetic resin can be made so that the direction in which the mold is removed from the die is one direction, and thus, the work of molding is easy.

[0018] A ratio of expansion α of the above described fan casing 1 can be set in a range from 4.0 to 7.0, and in this case, increase in the efficiency of the fan and reduction in the noise during operation are achieved when used with a large air volume.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019]

Fig. 1 is a front view showing a multi-blade centrifugal fan according to a first embodiment of the present invention;

Fig. 2 is a cross-sectional view taken along line 2-2 in Fig. 1;

Fig. 3 is a cross-sectional view taken along line 3-3 in Fig. 2;

Fig. 4 is a perspective view showing the impeller in the multi-blade centrifugal fan according to the first embodiment;

Fig. 5 is a cross-sectional view showing a main portion of the cylindrical body in the impeller of the multi-blade centrifugal fan which is an example not falling under the present invention.

Fig. 6 is a cross-sectional view showing a main portion of the cylindrical body in the impeller of the multi-blade centrifugal fan according to a modification of the first embodiment;

Fig. 7 is a characteristic graph showing changes in the performance of the fan when the ratio L/B of the length L of the cylindrical body to the length B of the blades starting from the main plate is changed in the

multi-blade centrifugal fan according to the first embodiment;

Fig. 8 is a characteristic graph showing changes in the performance of the fan when the ratio of expansion α of the fan casing in the multi-blade centrifugal fan according to the first embodiment is changed; Fig. 9 is a characteristic graph showing the location of the tongue portion of the fan casing relative to the width of the outlet of the impeller in the multi-blade centrifugal fan according to the first embodiment; Fig. 10 is a front view showing the multi-blade centrifugal fan according to an example not falling under the present invention.

Fig. 11 is a cross-sectional view showing a conventional multi-blade centrifugal fan;

Fig. 12 is a perspective view showing the impeller in the conventional multi-blade centrifugal fan; and

Fig. 13 is a cross-sectional view showing the multi-blade centrifugal fan according to a modification of the first embodiment.

BEST MODE FOR CARRYING OUT THE INVENTION

[0020] In the following, several preferred embodiments of the present invention are described with reference to the accompanying drawings.

First Embodiment

[0021] Figs. 1 to 4 show a multi-blade centrifugal fan according to a first embodiment of the present invention. As shown in Figs. 1 to 4, this multi-blade centrifugal fan is provided with a fan casing 1 of a scroll type. The fan casing 1 is provided with an air outlet 3, a pair of bellmouths 4 which face each other, and a tongue portion 5. Each bellmouth 4 forms an air intake. A multi-blade centrifugal impeller 2 having a number of annularly arranged blades 6 is placed inside the fan casing 1. Intakes 7 are created at the two ends of the impeller 2 in such a manner as to respectively face the above described bellmouths 4, and air drawn in through these intakes 7 is blown out in the centrifugal direction through the above described blades 6. The tongue portion 5 is a portion of the fan casing 1 at which the clearance between the inner peripheral surface of the fan casing 1 and the outer peripheral surface of the impeller 2 is minimal.

[0022] The impeller 2 is provided with a main plate 8, and a bearing 9 is provided in this main plate 8. The rotary shaft of a fan motor (not shown) is supported by the bearing 9. The multi-blade centrifugal fan according to the present embodiment is of a two-intake type with bellmouths 4 on the two side plates 1a of the fan casing 1, and the intakes 7 at the two ends of the impeller 2. Each blade 6 is a sweep forward blade in which a proximal end 6b is ahead of an inner end 6a in the direction of rotation M of the impeller 2.

[0023] Retainer rings 10 for retaining the above described blades 6 are respectively provided in the two end

portions of the above described impeller 2. A cylindrical body 11, which reaches substantially the same location as the end 4a of each bellmouth 4 on the outlet side, is integrally provided with and extends from each retainer ring 10. The outer end of each described cylindrical body 11 may reach such a location as to overlap with the end 4a of the bellmouth 4 on the outlet side or, as shown in Fig. 13, may be at a distance from the end 4a of the bellmouth 4 on the outlet side.

[0024] The effects of preventing circular flows are great in the case where the outer ends of the cylindrical bodies 11 reach substantially the same locations as the ends 4a of the bellmouths 4 on the outlet side, or in the case where the outer ends of the cylindrical bodies 11 reach such a location as to overlap with the ends 4a on the outlet side, and slightly inferior in the case where the outer ends of the cylindrical bodies 11 reach such locations as to be at a distance from the ends 4a of the bellmouths 4 on the outlet side.

[0025] Furthermore, the above described bellmouths 4 bulge outward from the side plates 1a of the fan casing 1. In this case, an annular space S is formed inside each bellmouth 4.

[0026] In the present embodiment, as shown in Fig. 3, the longitudinal cross section of the above described cylindrical body 11 extends in a circular arc form from the longitudinal cross section of the above described retainer rings 10. This configuration is preferable in that the flow of blown out air is guided smoothly. As shown in the example not falling within the present invention in Fig. 5, the longitudinal cross section of the above described cylindrical body 11 may extend linearly from the longitudinal cross section of the above described retainer rings 10. This configuration makes it easy to secure a clearance D from the inner peripheral surface of the tongue portion in the fan casing 1. Furthermore, as shown in Fig. 6, the longitudinal cross section of the above described cylindrical body 11 may extend in a circular arc form from the longitudinal cross section of the above described retainer ring 10, and further extend linearly. This configuration secures a clearance from the inner peripheral surface of the tongue portion 5 in the fan casing 1, and makes it easy to guide the flow of intake.

[0027] Tests were conducted to find out the performance of the multi-blade centrifugal fan having the above described configuration, by changing the ratio L/B of the length L of the cylindrical body 11 to the length B of the blades 6 starting from the main plate 8 (see Fig. 1), and the ratio of expansion α of the fan casing 1, and the results shown in Figs. 7 and 8 were gained. Although in the present embodiment, the peripheral surface 1b of the fan casing 1 is an Archimedean spiral, the same results can be gained in the case of a logarithmic spiral.

[0028] The ratio of expansion α of the fan casing corresponds to the spread angle of the spiral, and is represented by the following expression.

$$R_s(\theta_s) = r \cdot \exp(\theta_s \cdot \tan \alpha)$$

[0029] The sign r represents the reference minimum radius of the spiral (see Fig. 2), the sign R_s represents a radius in accordance with the angle θ_s of the spiral, and the sign θ_s represents the angle of the spiral relative to the origin corresponding to the reference radius of the spiral.

[0030] It was found out from the above described results that the efficiency of the fan is high and the specific sound level is low when L/B is in a range from 0.03 to 0.2. In the case of $L/B \geq 0.2$, the gap between the cylindrical body 11 and the inner peripheral surface of the fan casing 1 becomes small, and therefore, the efficiency of the fan lowers and the specific sound level becomes high. In addition, when the ratio of expansion α of the casing becomes great, the clearance D between the cylindrical body 11 and the inner peripheral surface of the fan casing 1 becomes large, and the Coanda effect due to the cylindrical body 11 becomes greater. In the case where the ratio of expansion α of the casing becomes too great, the performance lowers. Accordingly, it is desirable to set the ratio of expansion α of the above described fan casing 1 in a range from 4.0 to 7.0. In this configuration, increase in the efficiency of the fan and reduction in noise during operation are achieved when used with a large air volume.

[0031] Incidentally, as shown in Figs. 1 and 2, the outer form of the above described tongue portion 5 smoothly changes in the axial direction of the impeller 2 from the retainer rings 10 toward the main plate 8, so that the ridge line of the tongue portion 5 is in a V shape as a whole. The tongue portion 5A in Fig. 2 corresponds to the cross section along line 5A-5A in Fig. 1 which passes through the main plate 8 of the impeller 2, the tongue portion 5B corresponds to the cross section along line 5B-5B in Fig. 1, and the tongue portion 5C corresponds to the cross section along line 5C-5C in Fig. 1.

[0032] In addition, in Fig. 2, the form of the tongue portion 5 is shown using the angle θ formed between the reference line T_0 , which passes through the apex in the lateral cross section of the tongue portion 5A and the center of rotation of the impeller 2, and an imaginary line TL , which passes through the center of rotation of the impeller 2 and the apex of the tongue portion 5 in the lateral cross section in any location in the axial direction.

[0033] In this case, the angle θ in the tongue portion 5A is zero degrees. As shown in Fig. 9, at the width of the outlet of the impeller 2, the angle θ of the tongue portion 5 changes from zero degrees to an angle θ_A through an angle θ_C and an angle θ_B from the main plate 8 of the impeller 2 to the cylindrical body 11. It is desirable for the maximum value θ_{max} of the angle θ_A to be in a range from 5° to 30° . This configuration secures a predetermined clearance D between the outer peripheral surface of the cylindrical body 11 and the tongue portion

5 and prevents backflow of air into the impeller 2, so that the performance in terms of blowing wind is increased, and turbulent noise resulting from the rotation of the impeller 2 is reduced.

Example not falling within the present invention

[0034] Fig. 10 shows a multi-blade centrifugal fan according to an example not falling within the present invention.

[0035] This centrifugal fan is of a one-intake type and has a bellmouth 4 and an intake 7. The bellmouth 4 is located in the side plate 1a on the left side of the fan casing 1 and serves as an air intake. The intake 7 is located on the left end of the impeller 2 in Fig. 10. In this case, the height of the tongue portion 5 relative to the lower end 3a of the air outlet 3 is smoothly reduced toward the main plate 8 from the retainer ring 10 in the direction of rotation of the impeller 2 so that the entirety becomes inclined. This configuration makes the direction in which the mold is released one direction when the impeller 2 is formed of an integrated mold of a synthetic resin, and thus, the work of molding becomes easy. The other parts in the configuration and the advantages are the same as in the first embodiment, and therefore, the descriptions thereof are omitted.

[0036] It should be noted that the present invention is not restricted to each of the foregoing embodiments and a part of the structure can be appropriately changed and embodied without departing from the scope of the invention.

Claims

1. A multi-blade centrifugal fan, comprising a fan casing (1) having two side plates (1a) and a multi-blade centrifugal impeller (2), wherein the fan casing (1) is provided with a pair of bellmouths (4) which face each other and forming an air intake and an air outlet (3), and has a tongue portion (5), wherein the multi-blade centrifugal impeller (2) is arranged inside the fan casing (1) and has a number of annularly arranged blades (6), the multi-blade centrifugal impeller (2) draws in air through intakes (7) respectively facing the bellmouths (4) and blows the air out in the centrifugal direction through the blades (6), wherein outer peripheral end portions of the impeller (2) in the axial direction are provided with retainer rings (10) for retaining the blades (6), and a cylindrical body (11) is integrally provided in such a manner as to extend from an outer end of each retainer ring (10), wherein the bellmouths (4) bulge outward from the side plates (1a) of the fan casing (1) and an annular space (5) is formed inside each bellmouth (4), **characterized in that:**
a longitudinal cross section of the cylindrical body (11) extends in a circular arc from the longitudinal

cross section of the retainer rings (10) such that a circumferentially outer side of the cross section of the cylindrical body (11) extends outwardly in the centrifugal direction towards an axially outer end of the cylindrical body (11)..

2. The multi-blade centrifugal fan according to claim 1, **characterized in that** the cylindrical body (11) extends and reaches a location which is the same as an end (4a) of the bellmouth (4) or such a location as to overlap with the end (4a).
3. The multi-blade centrifugal fan according to claim 1 or 2, **characterized in that** a predetermined clearance (D) exists between the cylindrical body (11) and the tongue portion (5).
4. The multi-blade centrifugal fan according to claim 1, **characterized in that** the cylindrical body (11) is arranged at a distance from an end (4a) of the bellmouth (4).

Patentansprüche

1. Zentrifugalgebläse mit mehreren Schaufeln, umfassend ein Gebläsegehäuse (1), das zwei Seitenplatten (1a) und ein Zentrifugallaufrad mit mehreren Schaufeln (2) aufweist, wobei das Gebläsegehäuse (1) mit einem Paar von Einströmdüsen (4) bereitgestellt ist, die zueinander zeigen und einen Lufterlass und einen Luftauslass (3) bilden, und einen Zungenabschnitt (5) aufweist, wobei das Zentrifugallaufrad mit mehreren Schaufeln (2) innerhalb des Gebläsegehäuses (1) angeordnet ist und eine Zahl ringförmig angeordneter Schaufeln (6) aufweist, das Zentrifugallaufrad mit mehreren Schaufeln (2) Luft durch Einlässe (7) hereinzieht, die jeweils zu den Einströmdüsen (4) zeigen, und die Luft in der Zentrifugalrichtung durch die Schaufeln (6) ausbläst, wobei äußere Umfangsendabschnitte des Laufrads (2) in der Axialrichtung mit Rückhalteringen (10) zum Zurückhalten der Schaufeln (6) bereitgestellt sind, und ein Zylinderkörper (11) ganzheitlich auf solche Weise bereitgestellt ist, um sich von einem äußeren Ende jedes Rückhalterings (10) zu erstrecken, wobei die Einströmdüsen (4) sich von den Seitenplatten (1a) des Gebläsegehäuses (1) nach außen wölben und ein ringförmiger Raum (5) innerhalb jeder Einströmdüse (4) gebildet wird, **dadurch gekennzeichnet, dass:** ein Längsquerschnitt des Zylinderkörpers (11) sich in einem Kreisbogen vom Längsquerschnitt der Rückhalteringe (10) erstreckt, sodass eine umlaufende äußere Seite des Querschnitts des Zylinderkörpers (11) sich in der Zentrifugalrichtung nach außen hin zu einem axial äußeren Ende des Zylinder-

körpers (11) erstreckt..

2. Zentrifugalgebläse mit mehreren Schaufeln nach Anspruch 1, **dadurch gekennzeichnet, dass** der Zylinderkörper (11) sich erstreckt und eine Stelle erreicht, die dieselbe wie ein Ende (4a) der Einströmdüse (4) ist, oder solch eine Stelle, um mit dem Ende (4a) zu überlappen.
3. Zentrifugalgebläse mit mehreren Schaufeln nach Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** ein vorbestimmter Zwischenraum (D) zwischen dem Zylinderkörper (11) und dem Zungenabschnitt (5) besteht.
4. Zentrifugalgebläse mit mehreren Schaufeln nach Anspruch 1, **dadurch gekennzeichnet, dass** der Zylinderkörper (11) mit einem Abstand von einem Ende (4a) der Einströmdüse (4) angeordnet ist.

Revendications

1. Ventilateur centrifuge à multiples, comprenant un carter de ventilateur (1) présentant deux plaques latérales (1a) et une turbine centrifuge à multiples (2), dans laquelle le carter de ventilateur (1) est pourvu d'une paire de buses (4) qui se font face et formant une ouverture d'aspiration d'air et une sortie d'air (3), et présente une portion de languette (5), dans laquelle la turbine centrifuge à multiples (2) est agencée à l'intérieur du carter de ventilateur (1) et présente un certain nombre de pales (6) disposés de façon annulaire, la turbine centrifuge à multiples (2) aspire l'air à travers des ouvertures d'aspiration (7) faisant respectivement face aux buses (4) et souffle l'air vers l'extérieur dans la direction centrifuge à travers les pales (6), dans laquelle les parties d'extrémité périphériques extérieures de la turbine (2) dans la direction axiale sont pourvues de bagues de support (10) destinées à retenir les pales (6), et un corps cylindrique (11) est prévu d'une seule pièce de manière à s'étendre à partir d'une extrémité extérieure de chaque bague de support (10), dans laquelle les buses (4) font saillie vers l'extérieur à partir des plaques latérales (1a) du carter de ventilateur (1) et un espace annulaire (5) est formé à l'intérieur de chaque buse (4), **caractérisée en ce que** une section transversale longitudinale du corps cylindrique (11) s'étend en un arc circulaire à partir de la section transversale longitudinale des bagues de support (10) de sorte qu'un côté circonférentiellement extérieur de la section transversale du corps cylindrique (11) s'étend vers l'extérieur dans la direction centrifuge vers une extrémité axialement ex-

térieure du corps cylindrique (11)..

2. Ventilateur centrifuge à multipales selon la revendication 1,
caractérisée en ce que le corps cylindrique (11) est étendu et atteint un emplacement qui est le même qu'une extrémité (4a) de la buse (4) ou un emplacement tel qu'il coïncide avec l'extrémité (4a). 5
3. Ventilateur centrifuge à multipales selon la revendication 1 ou 2,
caractérisée en ce qu'un jeu (D) prédéterminé est présent entre le corps cylindrique (11) et la portion de languette (5). 10 15
4. Ventilateur centrifuge à multipales selon la revendication 1,
caractérisée en ce que le corps cylindrique (11) est agencé à une certaine distance d'une extrémité (4a) de la buse (4). 20

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Fig.1

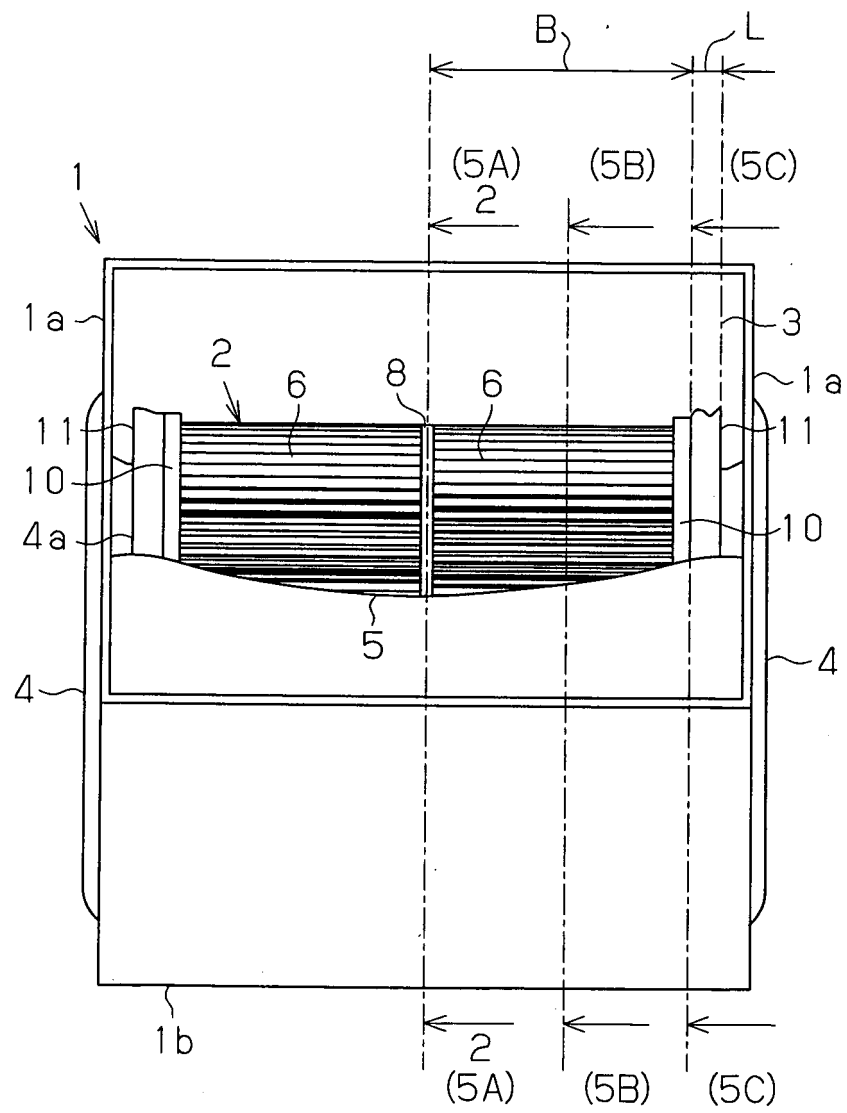


Fig.2

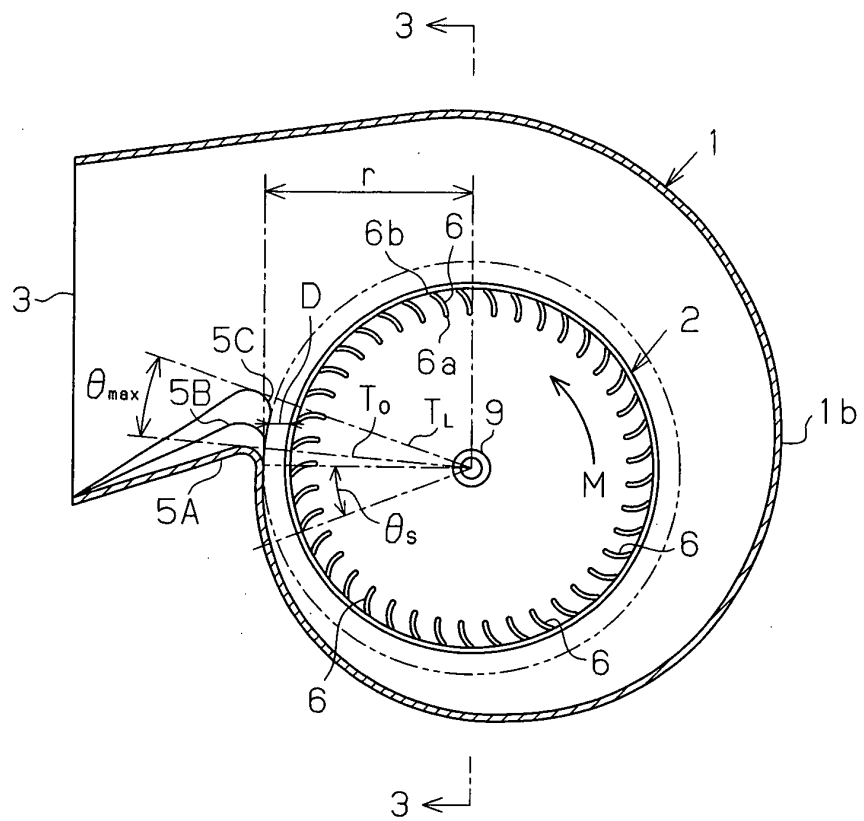


Fig.3

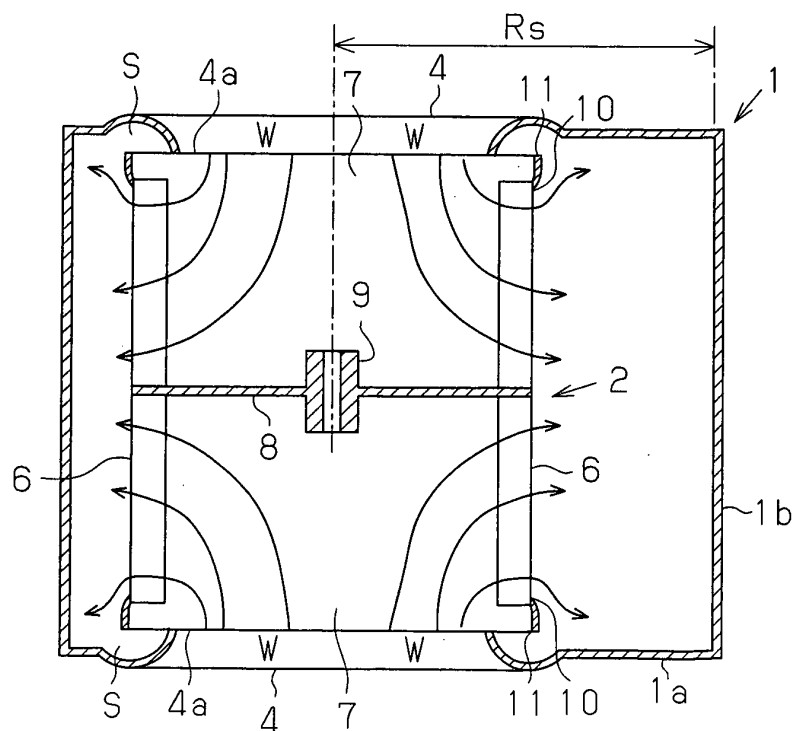


Fig.4

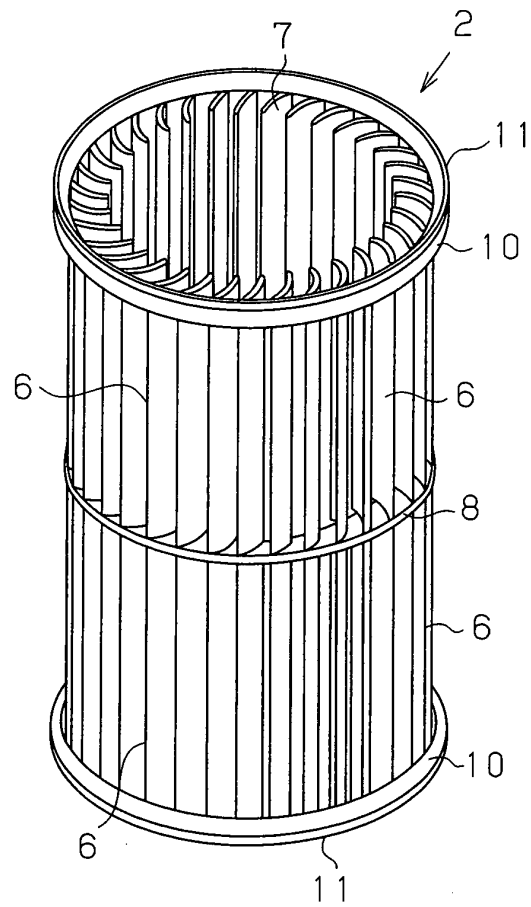


Fig.5

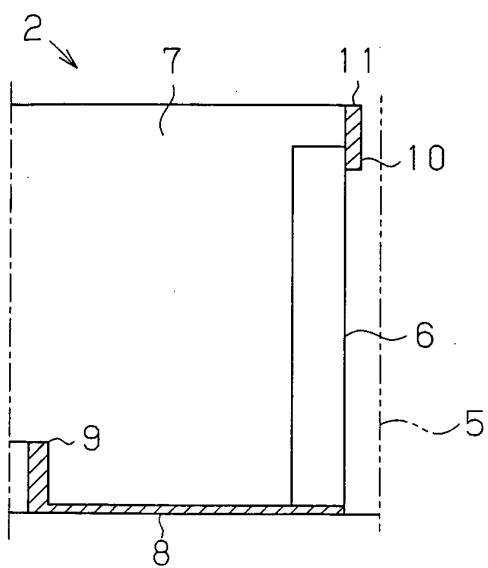


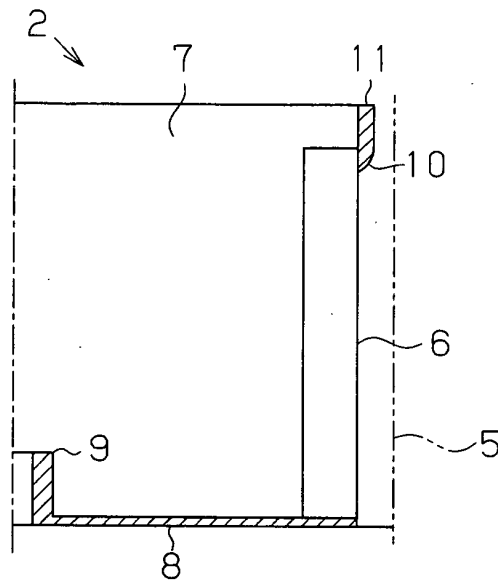
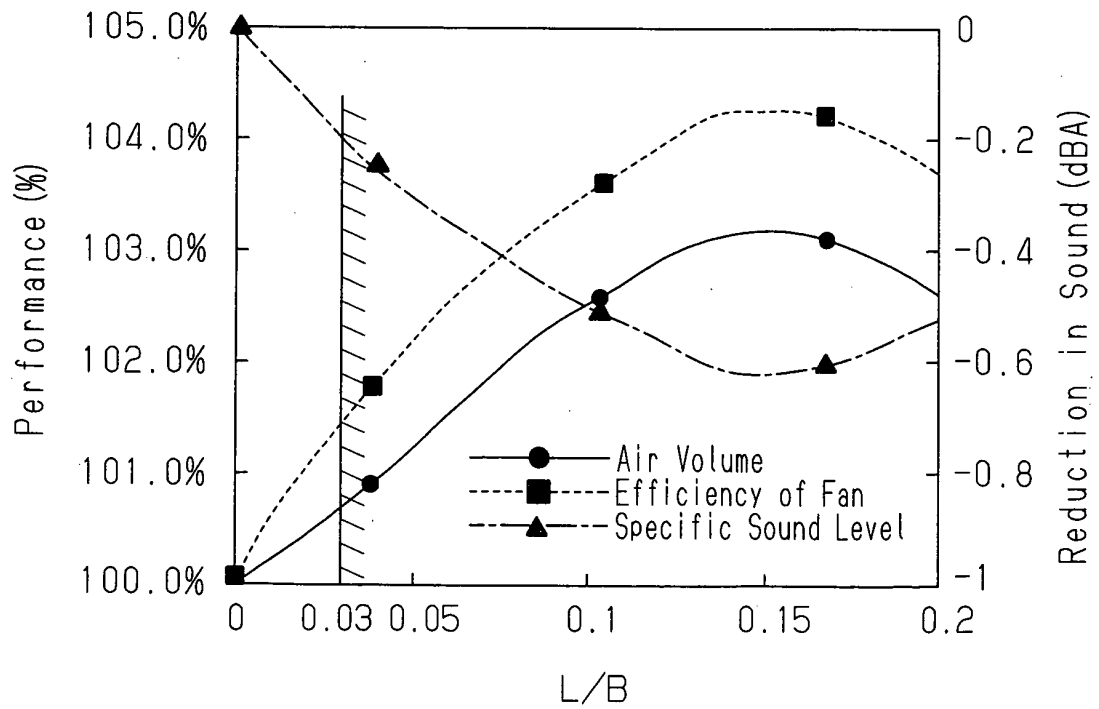
Fig.6**Fig.7**

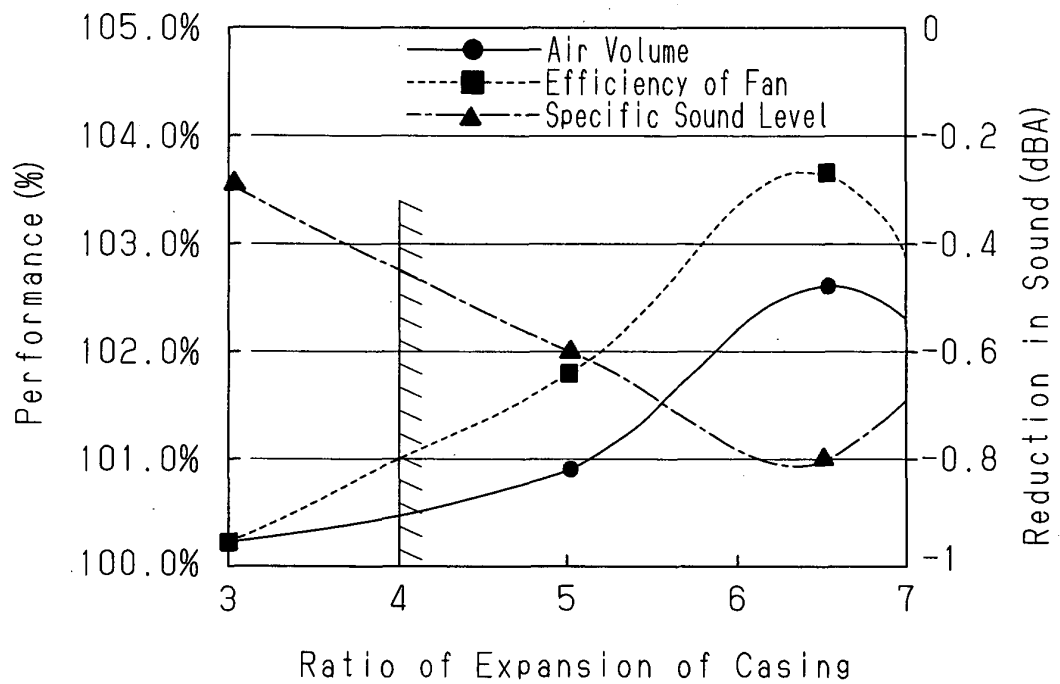
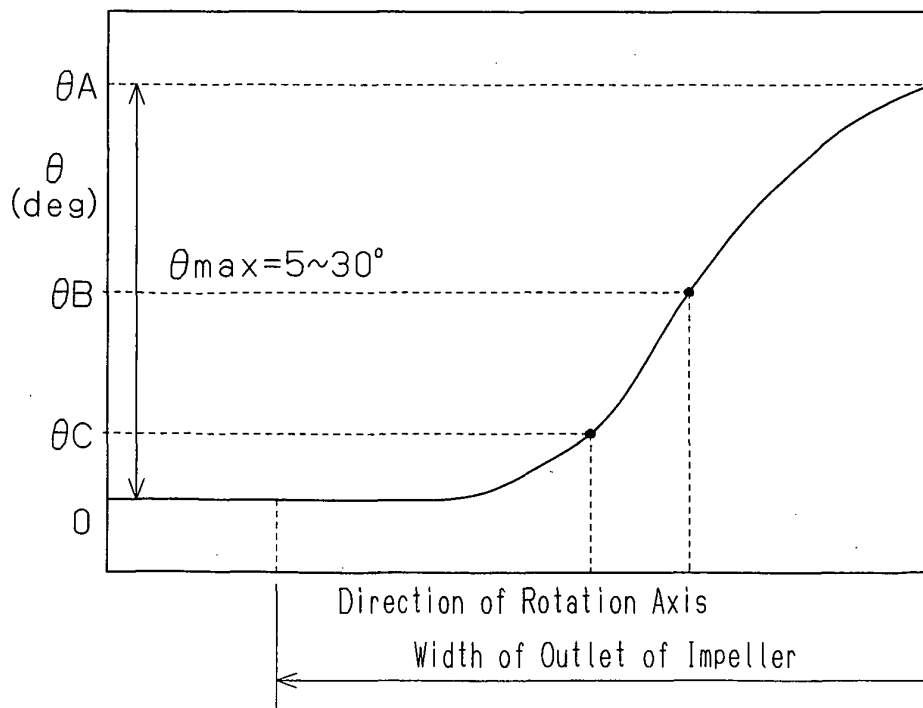
Fig. 8**Fig. 9**

Fig.10

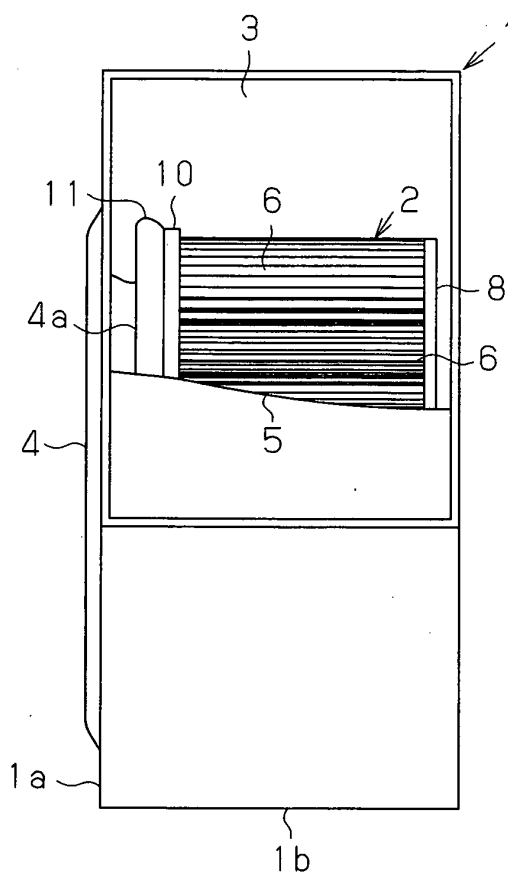


Fig.11

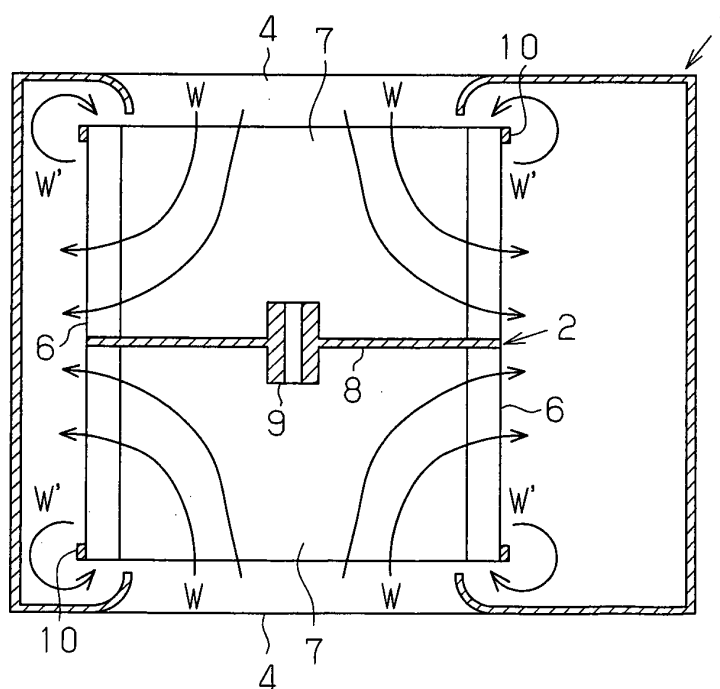


Fig.12

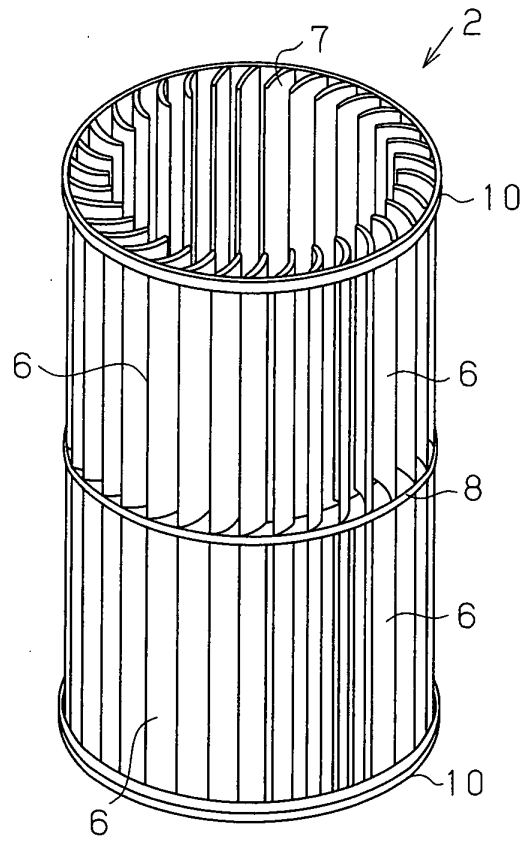
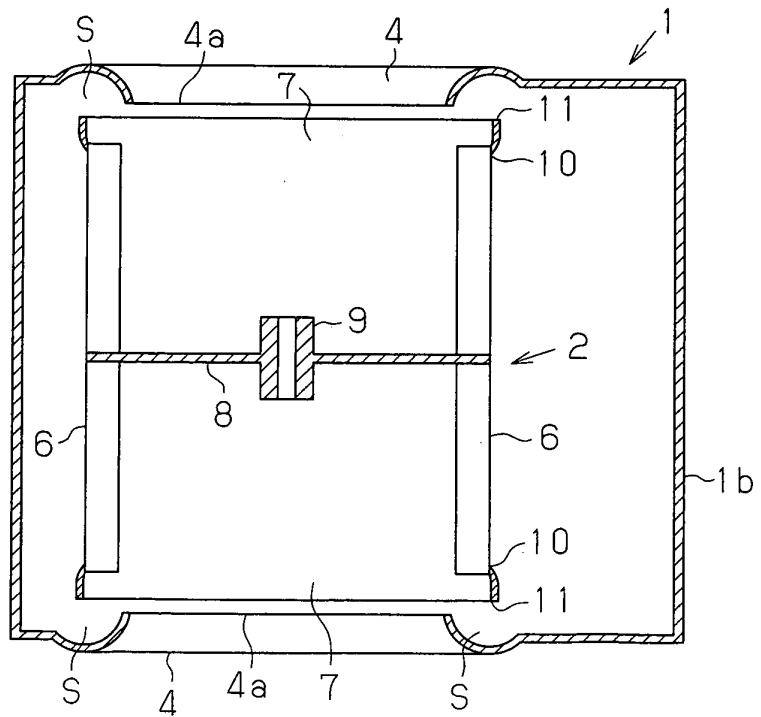


Fig.13



REFERENCES CITED IN THE DESCRIPTION

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